**DOCUMENT RESUME**

**ED 147 608** **CE 014 059**

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|---|---|
| AUTHOR | Bragg, Jack M., Comp.; Hunter, Wallace D., Comp. |
| TITLE | A Catalog of Performance Objectives, Criterion-Referenced Measures and Performance Guides for Combination Welding, Revised. |
| INSTITUTION | Clemson Univ., S.C. Vocational Education Media Center. |
| SPONS AGENCY | South Carolina State Dept. of Education, Columbia. Office of Vocational Education.; Vocational Technical Consortium of States, Atlanta, Ga. |
| PUB DATE | 77 |
| NOTE | 77p. |
| EDRS PRICE | MF-$0.83 HC-$4.67 Plus Postage. |
| DESCRIPTORS | *Behavioral Objectives; *Criterion Referenced Tests; Metal Working Occupations; Performance Based Education; Performance Criteria; Performance Factors; Secondary Education; *Task Performance; Teaching Guides; *Trade and Industrial Education; *Welding |
| IDENTIFIERS | South Carolina |

ABSTRACT

This V-TECS (Vocational-Technical Education Consortium of States) catalog was revised for use by South Carolina instructors in organizing or supplementing their curriculum guides for welding instruction. Contents include performance objectives and criterion referenced measures associated with current occupational information relating to the job content of combination welding. Each performance objective contains the following elements: (1) the condition under which the student will perform the objective, (2) the performance required of the student after instruction has taken place, and (3) a job-relevant standard for measuring successful performance of the objective. The criterion referenced measures are items designed to test student achievement of the performance objectives and are test situations which instruct the student to perform a certain action. The performance guides which accompany most of the objectives and measures are procedural steps identified as subordinate to task performance. They may require slight modification. Only one performance guide is given per item, though there may be several ways to approach the objective. An equipment and tool listing showing the numbers and percentages of workers using each piece of equipment is appended, as well as a list of references used to document the sources of the standards for the objectives, and a state-of-the-art survey. (BL)

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VOCATIONAL-TECHNICAL EDUCATION CONSORTIUM OF STATES

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# A Catalog of Performance Objectives, Criterion Referenced Measures and Performance Guides

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# WELDING

CE 014 059

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**REVISED FOR USE IN SOUTH CAROLINA**

# A CATALOG

# OF PERFORMANCE OBJECTIVES, CRITERION-REFERENCED

# MEASURES AND PERFORMANCE GUIDES FOR

# COMBINATION WELDING

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December, 1976

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ACKNOWLEDGEMENTS

This V-TECS catalog for Combination Welding was revised for the South Carolina vocational education curriculum through the cooperative effort of the State Vocational Education Department and welding teachers from four vocational schools.

The teacher committee consisted of:

Mr. Ralph Bedenbaugh - Crescent Cities Vocational Center

Mr. R. H. Gandy - Darlington Career Center

Mr. Sonny Shaw - Airport High School

Mr. J. R. Toney - R. D. Anderson Area Vocational Center

The committee was organized through the direction of John Lykes, District I, Trade and Industrial Consultant

Guidelines for implementing the V-TECS Combination Welding Catalog were directed by Richard Davenport, Vocational Education Media Center, Clemson University.

## PREFACE

The State of South Carolina is a member of the Vocational-Technical Consortium of States, a cooperative organization which has as its purpose the production of catalogs of performance objectives and criterion-referenced test items in occupational education. The ultimate goal of V-TECS is to provide a means for more relevant occupational training through teaching students to perform those tasks which are actually done in the real world of work. The performance objectives and criterion measures are based on a comprehensive survey of incumbent workers.

A committee of four welding teachers from South Carolina was organized to evaluate and implement this V-TECS Catalog for use in the vocational welding curriculum. The original catalog was developed by the State of Florida.

The committee utilized the following steps in modifying the catalog for South Carolina vocational education:

1. Reviewed the catalog contents.
2. Selected tasks to be taught.
3. Added new tasks along with the appropriate objective, criterion reference and performance guide.
4. Sequenced the tasks according to prerequisite order.
5. Suggested reference materials.
6. Reviewed and evaluated the revised catalog.

This revised edition of the Combination Welding V-TECS Catalog should help instructors organize or supplement their curriculum guides for welding instruction. The performance objectives should be adopted by each instructor to meet their particular equipment, texts, tools and students.

# INTRODUCTION

The Vocational-Technical Education Consortium of the States (V-TECS) was formed for the purpose of developing catalogs of performance-based objectives with criterion referenced measures in July 1973. The membership, consisting of Alabama, Delaware, Florida, Georgia, Kentucky, Louisiana, Indiana, Maryland, Michigan, Mississippi, South Carolina, Tennessee, Virginia, West Virginia and Wisconsin, has directed its efforts to develop catalogs to be shared by all member states.

The Air Training Command of the U. S. Air Force and The Research and Program Development of the U. S. Navy Education and Training Command are associate members.

Many benefits are realized by sharing the catalogs and products developed by the member states. Since all catalogs are developed under the same guidelines, confidence and transportability across state lines prevents expensive duplication. Occupational education is continuously changing and by sharing research and development it is anticipated that the benefits will grow with consortium.

A model has been devised which is used by all states developing catalogs to ensure confidence in the products developed and to promote transportability among states.

The major components of the format are:

1. A comprehensive state-of-the-art study
2. A domain study report
3. Selection and preparation of a writing team
4. Development of an occupational inventory
5. Validation of the inventory by interviewing incumbent workers and their supervisors
6. Selection of a random sample of incumbent workers within the state developing the catalog
7. Administration of the occupational inventory to the incumbent worker sample

8. Computer analysis of the data collected from the sample
9. Conversion of the task statements into performance objectives and criterion-referenced measures with performance guides by the writing team
10. A comprehensive field review of the catalog
11. Revision of the catalog as determined by the field review
12. Diffusion of the catalog

A Technical Coordinator in each state monitors the developing model and serves as a resource person for project personnel.

The reports and products developed within the state are reviewed by both the State's Technical Coordinator and the V-TECS Technical Specialists to assure that quality criteria have been met.

## DEFINITION OF TERMS

Catalog. A comprehensive collection of performance objectives, performance guides, criterion-referenced measures, and related data, organized by a job structure or career ladder within a domain of interest.

Criterion-Referenced Measure. An exercise based upon a performance objective, the accomplishment of which measures attainment of that objective.

Domain. A cluster of related jobs.

D.O.T. Code. A nine-digit number used to identify a specific job within a given domain.[1]

Duty. One of the distinct major activities involved in the work performed, comprising related tasks.

Educational Consortium. A group of state agencies, institutions, or other entities which have been legally constituted through letters of commitment, agreements, or by assignment of higher authorities to work together toward the solution of problems in education. A consortium for the purposes of this work, must have membership from autonomous agencies and institutions which cut across state boundaries as they attempt to solve problems or meet goals.

Job. The duties and tasks actually performed by a specific individual.

Occupational Education. An organized sequence of learning experiences consisting of vocational theory, practice, and skill for students on a regular or systematic basis.[2]

Occupational Inventory. A listing of tasks to be performed in a particular occupational area, grouped under duty classifications.

O. E. Code. A six-digit number used to identify a specific domain.[3]

Performance Guide. A series of steps, arranged in a sequence ordinarily followed, which when completed may result in the performance of a task. Also called "teaching steps."

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[1]Also see Vocational Education and Occupations (July, 1969). (Washington: Government Printing Office, Catalog FS 5.280:80061, 1969).

[2]Standards of the Delegate Assembly (Atlanta: Southern Association of Colleges and Schools, Commission on Occupational Education, December, 1972), p. 12.

[3]V. E. O. (op. cit.).

Performance Objective. A statement in precise, measurable terms of a particular behavior to be exhibited by a learner under specified conditions. It possesses each of the elements or characteristics specified below:

a. Condition - The testing situation confronting the learner is clearly specified. This includes equipment provided or withheld, environmental constraints such as temperature, space, etc.

b. Performance - The specific behavior expected of the learner is stated.

c. Standard - The degree of acceptable performance is specified. This may be quantitative, qualitative, or both. If quantitative, 100% proficiency is assumed unless otherwise stated. In the standard, "...locate shorts in an ignition system" it is assumed that all shorts must be located, compared to "... located 3 of 4 shorts existing in an ignition system." If qualitative, the standard is explicitly stated, e.g., "... measure the bearing to within .005" of that found by the instructor." If the measure of quality is highly subjective, the instructor is assumed to be the judge of acceptable performance unless otherwise stated. This judgment may be made using a checklist, or it may be strictly a "go no-go" decision.

Task. A unit of work activity or operation that constitutes a logical and necessary step in the performance of a duty.

Task Analysis. A process of reviewing actual job content and context in business and industry for application to the development of performance objectives, criterion-referenced measures, and quality control within a program of vocational-technical education.

Task Criticality. A characteristic of a task statement which makes its accomplishment crucial to the acceptable performance of a worker. A method of analysis which identifies the critical tasks and aids in determining the consequence of poor performance or lack of performance by a worker.

Task Difficulty Index. An index to determine the relative difficulty of each task performed within the domain of interest. This information is collected from selected workers and their immediate supervisors.

Task List. A listing of tasks performed by incumbent workers within a domain of interest. An example is a listing of all tasks performed by an automotive mechanic or by a worker in ornamental horticulture.

Task Time-Spent Index. An index of relative time-spent on each task within a domain of interest and appearing on a task list. The task time-spent index is computed from scientifically selected samples of incumbent workers who respond to task listings.

## PURPOSE OF THE CATALOG

This catalog was designed to provide performance objectives and criterion-referenced measures associated with current occupational information relating to the job content of Combination Welding. The catalog may serve other functions, including the following:

1. Objectives may be compared to existing programs for possible inclusion.
2. Criterion-referenced measures may be used to test effectiveness of instruction in terms of measurable student achievement.
3. Measures may be used to determine entering student competencies, thus allowing for such things as advanced placement and individualization of instruction.
4. Measurement outcomes may be used to accept, improve, or reject an instructional procedure or system.
5. Performance guides may be used as a blueprint for designing curriculum which will support selected performance objectives.
6. Performance guides may be used as teaching points for the instructor, who may choose to develop supporting instructional objectives which are interim rather than terminal in nature.

## DEVELOPMENT OF THE CATALOG

The methodology for the conduct of the project performance objectives and criterion-referenced measures for Combination Welding is described in the following paragraphs.

### Description of the Sample

a. The following D.O.T.'s and job titles were used in the survey:

(1) 812.884-014 Welder, Combination
(2) 812.884-010 Welder, Combination Apprentice
(3) 812.884-018 Welder, Production Line
(4) 812.884-022 Welding Repair

b. The sample size was determined by V-TECS to be 154 based on identification of 655 businesses in the State of Florida. Seventy-seven of these businesses were sampled.

c. The rate of response to a mail survey was considered insufficient for analysis. A personal interview technique was employed which resulted in a rate of response to the occupational booklet of 84% yielding 130 usable returns.

d. The reliability of the instrument as determined by coefficient alpha was .90286.

### Preliminary Research

The search for information in the Combination Welding field began with The Florida Educational Resources Information Center (FERIC). Thirty-two (32) documents proved to be of significant value and extracts were written on each. The Navy and Air Force provided valuable task list and curriculum development materials. Four (4) technical and related publications were reviewed and considered relevant to the project and extracts were written. (Using the task lists provided by the military services, the subject breakdown for testing by Educational Testing Service (ETS) and personal interviews with incumbent workers and supervisors a task list was developed.)

A state of the art study was conducted as a basis for developing the catalog on combination welding. The State of the Art and related documents

are available through the Bureau of Research and Evaluation, Division of Vocational Education, Florida Department of Education, Tallahassee, Florida. A review of the State of the Art literature is found in Appendix (C ). In addition, using the available task lists as a basis, extensive interviews were conducted with incumbent workers to clarify and extend the lists. The lists were further refined through consultation with the Craft Advisory Committee for the Pensacola area.

Following the development of the occupational survey, the instrument was pre-tested with a selected group of welder supervisors and incumbent workers before the conducting of the sample of the incumbents in the State of Florida.

Analysis of Data

Computer analysis of the collected data was provided to the members of the project staff. The following reports were provided:

1. Index of time spent performing tasks.
2. Standard deviation of time spent values.
3. Duty/Task List.
4. Percentage of worker performance tasks.
5. Equipment used by worker.

Selection Of The Writing Team

A team of content specialists worked with the Project Director and the Technical Coordinator in reviewing and refining the tasks and duties to be analysed for inclusion in the catalog of the combination welding. Performance objectives, criterion-referenced measures, and performance guides were developed for the job-related tasks. The team was selected on the basis of recommendations from state and local administrators, from demonstrated competency in welding, and from those willing to serve. Representation was present from the community colleges, vocational-technical institutes, and secondary school programs. In addition, incumbent workers and supervisors were consulted as needed by the writing team.

The Field Review

The purpose of the field review of the Combination Welding Catalog was to provide additional validation of the catalog through:

1. A careful review of all sections of the catalog.
2. An evaluation of each performance objective, criterion-referenced measure, and performance guides for each job related task. This evaluation was in terms of a "Yes" "No" response as to whether the criteria were met.
3. An opportunity to provide editorial or word changes which would clarify the catalog.

The Field Review Team consisted of 1). 13 instructors in the welding field in community colleges, vocational-technical institutes, and secondary schools; 2). supervisors for incumbent workers, incumbent workers; and, 3). a state administrator having responsibility for supervision in curriculum development in the field. The Manager of Education for the American Welding Society kindly consented to review the catalog and provided helpful and insightful comments. The Field Review Team was selected on the basis of competency and familiarity with competency-based instruction. Participation from all was excellent and helpful suggestions for changes were freely provided.

## ELEMENTS OF THE CATALOG

This catalog is comprised of performance objectives, associated criterion-referenced measures, and performance guides which were prepared from job-related task statements from the occupational inventory.

Each performance objective contains the following elements: (1) the condition under which the student will perform the objective, (2) the performance required of the student after instruction has taken place, and (3) a job-relevant standard for measuring successful performance of the objective. The source of the standard for each objective is documented from one of the three sources outlined below:

1. The primary source of performance standards is job-based information provided in technical manuals, certification requirements, or other germane literature.

2. The secondary source of performance standards is the level of performance agreed upon by incumbent welding technicians and supervisors who served on the writing team or as consultants to the team.

3. The third source of performance standards is the subject matter specialists on the writing team. However, specialists are used only as resources when the first two sources are unavailable.

The source of the standard is identified in parentheses after each performance objective, i.e., (4) or (5:49). The first number, (5), refers to a source identified in the List of References and the second number, 49, refers to the page number in the source if there is a page number. The symbol @ indicates an attachment that cannot be computerized. Listing of a reference in no way implies that this is the only source of an appropriate standard and certainly should not be construed as blanket endorsement of the organization or publication from which the standard was secured. There may be other valid sources in addition to the one cited.

The criterion-referenced measures are items designed to test student achievement of the performance objectives. They are test situations which instruct the student to perform a certain action.

The performance guides which accompany most of the objectives and measures are procedural steps identified as subordinate to task performance. They may require slight modification because of equipment differences, availability of tools, local practice, etc., and are suggested items. Only one performance guide is given per item, though there may be several ways to approach the objective.

The catalog contains five appendices. An equipment and tool listing is included in Appendix A showing the numbers and percentages of workers using each piece of equipment. Appendix B is a list of references used to document the sources of the standards for the objectives. Appendix C is a listing of related materials included in the state-of-the-art study conducted prior to the development of the preliminary occupational inventory booklet. Appendix D consists of a cross-reference table designed to aid teachers in adapting the objectives to individual programs. Appendix E provides a listing of performance objectives with figures indicating percent of members performing and time spent indexes.

# PERFORMANCE OBJECTIVES,
# CRITERION-REFERENCED MEASURES,
# AND PERFORMANCE GUIDES

NOTE: Most welding training areas have standardized acceptable welded joints displayed. These displays may be used for acceptable standards of proficiency.

**Duty:** RELATED INSTRUCTION

**Task:** Demonstrate Knowledge of the Welding Industry and History

1. Performance Objective

Upon completion of the instruction, answer questions concerning the welding industry and history, with 90% proficiency.

Criterion-Referenced Measure

The student will demonstrate knowledge of the welding industry and history by completing a written test.

Performance Guide

1. Listen to instruction on the welding industry and its history.
2. Read "Orientation to Welding" by Raymond Sacks, printed by Charles A. Bennett Co., Peoria, IL, 1976
3. Study related material assigned by the instructor.

**Duty:** RELATED INSTRUCTION

**Task:** Demonstrate Knowledge of First Aid and Safety

---

2. Performance Objective:

After instruction on First Aid and Safety, the student must pass an examination with 90% proficiency.

Criterion-Referenced Measure:

The student should be able to demonstrate knowledge of First Aid and Safety.

Performance Guide:

1. Listen to instruction on First Aid and Safety Measures.
2. Define the terms described.
3. List five rules for personal safety.
4. Learn OSHA regulations that apply to welding.
5. Learn to identify unsafe shop practices.
6. Learn safety color codes and their use.
7. Learn First Aid measures to control bleeding, restore breathing, treat for burns, treat for poisons, shock and protect wounds.
8. Learn safe use of welding equipment and tools. (See "Safety precautions for Oxygen and Acetylene," South Carolina Curriculum Guide for Welding - 1972).

**Duty:** RELATED INSTRUCTION

**Task:** Read and Interpret Detail Sketch From Blueprint

---

3. Performance Objective

Given a blueprint; read and interpret by writing the name and purpose of all welding symbols, lines and views that apply to welding fabrication. The names and purposes of symbols, lines and views listed will be 90% accurate. (1)

Criterion-Referenced Measure

Write the names and purposes of lines, views and symbols from a blueprint.

Performance Guide

1. Locate welding symbols and interpret meaning.
2. Locate lines and interpret meaning.
3. Identify views.
4. List the symbols, lines and views and their meaning.

**Duty:** RELATED INSTRUCTION

**Task:** Select Metals for Fabrication From Blueprint Specifications

---

4. Performance Objective

Given a blueprint with specifications for types of metal for a fabrication job; use the blueprint and code book to select metals. Selection will comply to specifications on the blueprint without error. (1)

Criterion-Referenced Measure

Use code book and blueprint to select metal for fabrication.

Performance Guide

1. Read and interpret blueprint specifications.
2. Identify metals from code numbers, e.g., A151, ASTM, SAE, AISI Aluminum Association, AWS, ASME, or other governing agency.
3. Select appropriate material for processing.
4. Record on paper your selection.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Set Up Portable or Stationary Oxy-Fuel Equipment

---

5. Performance Objective

Given oxyacetylene torch, regulators, hoses, check valves, cylinder wrench, oxygen and fuel cylinders and portable car; set up a portable or stationary outfit. The oxy-fuel equipment will not leak and will operate safely as the manufacturer intended. (1)

Criterion-Referenced Measure

Set up a portable or stationary oxy-fuel outfit.

Performance Guide

1. Chain cylinders to the cart.
2. Remove cylinder caps.
3. Crack cylinder valves to clean out foreign particles and inspect threads.
4. Attach regulators.
5. Install check valves.
6. Attach hoses to torch.
8. Check for leaks.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Perform Soap And Water And/Or Submerged Leak Test and Repair Gas Welding Equipment.

---

6. Performance Objective

Given gas welding equipment to be tested for leaks, neutral soap and water; perform a soap and water and/or submerged leak test. All discovered leaks will be identified, marked with tape and repaired. Hoses and torch will not leak after repair and test. (1)

Criterion-Referenced Measure

Perform soap and water and/or submerged leak test on gas welding equipment and repair as necessary.

Performance Guide

1. Close torch valves.
2. Apply normal pressure.
3. Mix neutral soap and water (not required for submerged leak test).
4. Brush soapy water over hoses and valves or completely submerge hoses and torch unit.
5. Check for bubbles.
6. Mark discovered leaks with tape.
7. Relieve hose pressure.
8. Repair hoses and torch as required.
9. Recheck for leaks.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Wire Brush With Power Equipment

---

7. Performance Objective

Given metal to prepare for welding, power wire brush and personal safety equipment; clean mill scale, rust and other foreign matter from metal. Cleaned metal must be visually free of all foreign matter. (1)

Criterion-Referenced Measure

Wire brush metal to remove foreign matter in preparation for welding.

Performance Guide

1. Select safety equipment.
2. Select proper equipment.
3. Visually inspect condition of equipment for safety.
4. Wire brush in preparation for welding.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Clean Welding and Cutting Tips on Oxy-Fuel Equipment

---

8. Performance Objective

Given oxy-fuel equipment and tip cleaners; clean both cutting and welding tips. Finished tip will be filed square, orifice hole(s) round and free of all foreign particles. (1)

Criterion-Referenced Measure

Clean oxy-fuel cutting and welding tips.

Performance Guide

1. Examine the tip to determine orifice size and condition of orifice end of tip.
2. Select proper tip cleaners.
3. File orifice end.
4. Clean tip using a tip cleaner 2 sizes smaller than the tip orifice. Use straight push-pull action to eliminate egg-shaped hole. Gradually increase tip cleaner size to original orifice size:
   (a) Where possible, use long tip cleaners and insert through back of tip.
   (b) Clean welding tips and cutting tips that cannot be cleaned from the back through the orifice end.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Cut Carbon Steels With Oxy-Acetylene Equipment

9. Performance Objective

Given oxy-acetylene equipment, work order requiring different thicknesses of carbon steel ranging from 1/4" (6.3 mm) to 1 1/4" (31.5mm); make the following type cuts; straight,angle; slot; bevel; circle; and piercing. Cuts must meet a tolerance of ±3/32" (2.5). (1)

Criterion-Referenced Measure

Cut carbon steel using oxy-acetylene equipment according to work order specifications.

Performance Guide

1. Select safety equipment.
2. Determine grade of steel using (a) spark stream; (b) code number.
3. Measure and mark with soapstone.
4. Select proper torch tip.
5. Check all fittings, hoses, regulators for proper condition.
6. Adjust regulators, light and adjust torch.
7. Cut metal according to instructions on work order.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Cut Metal Using MAPP Or Propane Type Gas Equipment

---

10. Performance Objective

Given MAPP or propane base type fuel cutting equipment, work order specifying a minimum of three thicknesses of mild steel ranging from 1/8" (3mm) to 1 1/" (38.0mm); set up cutting equipment and cut metal ±3/32" 2.5mm) of work order specifications. (1)

Criterion-Referenced Measure

Cut metal using MAPP or propane base type cutting equipment according to work order specifications.

Performance Guide

1. Select safety equipment.
2. Clean metal and prepare for cutting.
3. Select and set up cutting torch and correct size tip.
4. Cut metal according to work order.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Gas Weld Carbon Steels

---

11. Performance Objective

Given work order, carbon steel, oxyacetylene welding equipment and tools; weld joint(s). Weldment must have even weld beads, penetration of parent metal and complete fusion with smooth even beads minus holes, craters or undercut. (1)

Criterion-Referenced Measure

Gas weld carbon steel joint(s).

Performance Guide

1. Select safety equipment.
2. Clean and prepare joints.
3. Select tip and filler rod.
4. Weld joints.
5. Clean and check welds.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Running A Bead Without Filler Rods

---

12. Performance Guide

The student must run a bead on light gauge metal in the vertical, horizontal, overhead and flat positions without a filler rod, according to the instructor's standard.

Criterion-Referenced Measure

After running a bead without filler rod, the student will show the work to the instructor.

Performance Guide

1. Observe the instruction on running a bead.
2. Select proper welding tip, gas pressure and safety equipment.
3. Prepare metal for welding.
4. Place metal in welding position.
5. Turn on oxyacetylene unit.
6. Set working pressure (according to manufacturer's recommendations).
7. Light torch and adjust to a neutral flame.
8. Place inner cone about 1/16" to 1/8" from metal.
9. Do not begin travel until you have established a molten puddle.
10. Hold torch $30^{o}$ to $45^{o}$ from center in direction of travel.
11. Slowly move the torch forward allowing the metal to melt.
12. Repeat process until instructor gives permission to go on to next job.
13. Run beads on strips of light gauge sheet metal (1 1/4" x6") in all four positions.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Running a Bead with Filler Rods

---

13. Performance Objective

Given light gauge metal (1/16", 3/32" and 1/8"). The student must run beads in all four positions using filler rods. The beads must meet the instructor's specifications.

Criterion-Referenced Measure

After running beads on three gauges of metal with filler rods, the student will show them to the instructor.

Performance Guide

1. Listen and observe instruction.
2. Prepare metal for welding.
3. Place metal in welding position.
4. Turn on oxyacetylene unit.
5. Set working pressure (according to manufacturer's recommendations).
6. Light torch and adjust to a neutral flame.
7. Hold torch 30° to 45° from center.
8. Place inner cone about 1/16" to 1/8" from surface of puddle.
9. Do not begin travel until you have established a molten puddle.
10. Add filler rod to front edge of puddle in front of torch.
11. Move puddle forward with torch and allow puddle to form in base metal.
12. Add rod and withdraw rod to front edge of puddle as you move puddle forward.
13. Keep puddle the same size and shape the entire length of the bead.
14. Show bead to instructor when completed.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Welding Joints

---

14. Performance Objective

Given a 3/32" mild steel filler rod, the student must weld a Butt, Flange, Corner, Lap and Tee Joint in all four positions. The joints will be evaluated to the instructor's standards.

Criterion-Referenced Measure

The student will take the 3/32" mild steel filler and weld the assigned joint.

Performance Guide

1. Observe instruction.
2. Select proper welding tip, gas pressure and safety equipment.
3. Prepare metal for welding.
4. Place metal in welding position.
5. Turn on oxyacetylene unit.
6. Set working pressure (according to manufacturer's recommendations).
7. Light torch and adjust to a neutral plane.
8. Tack weld metal together at both ends of joint.
9. Hold torch $30^{\circ}$ to $45^{\circ}$ from center.
10. Do not begin travel until you have established a molten puddle.
11. Place inner cone about 1/16" to 1/8" from surface of puddle.
12. Add filler rod to front edge of puddle in front of torch.
13. Move puddle forward with torch and allow puddle to form in base metal.
14. Add rod and withdraw rod to front edge of puddle as you move puddle forward.
15. Keep puddle the same size and shape the entire length of the bead.
16. Weld a Butt, Flange, Corner, lap and Tee Joint.
17. Weld each joint in all four positions - vertical, horizontal, flat and overhead.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Welding Vee Grove Butt Joints on Light Steel Plates

---

15. Performance Objective

Given oxyacetylene equipment, filler rod, and 3/16" steel plates, the student must make a vee-groove butt weld in the flat, horizontal, vertical, and overhead positions, to the instructor's specifications.

Criterion-Referenced Measure

Weld a vee grove butt joint in the four specified positions.

Performance Guide

1. Set up and adjust oxyacetylene equipment to the setting specified.
2. Light torch and adjust to neutral flame.
3. Bevel the 3/16" plate to a $30^{o}$ angle.
4. Space pieces 1/8" apart and tack weld at each end.
5. Position pieces on fire brick in a fixture in the flat position, with nothing touching work pieces in the area of the groove.
6. Establish puddle at the tack weld and proceed to weld from right to left.
7. Keep keyhole open and apply filler rod at regular intervals to maintain even penetration.
8. Run the finish or second pass to bring the weld bead up to the desired height and width.

NOTE: (The finish bead may require less flame than the root pass).

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Welding Pipe Joints 1 1/2" and 2" Diameter with the Rolling Method

---

16. Performance Objective

Given pipe and the oxyacetylene welding equipment, weld pipe in the horizontal rolling position. The weld must meet the instructor's specifications.

Criterion-Referenced Measure

Prepare and weld pipe using the rolling method to the instructor's standard.

Performance Guide

1. Check safety equipment to make sure it is all present and in good order.
2. Set up equipment and adjust to desired setting.
3. Clean and bevel to 30° angle, grinding would be the best method.
4. Stand pipe vertically with bevels together.
5. Space pipe with short welding wire 1/8" diameter.
   NOTE: The spaces should be in vertical shape.
6. Light torch and adjust to neutral flame.
7. Put one small tack between open ends of wire spaces.
8. Remove spacer, and put two more small tacks equal distance around pipe, maintaining proper spacing.
9. Move pipe to horizontal roll position and proceed with weld in the general area of two and three o'clock. (Point the flame toward the center of the pipe).

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Welding Pipe 1 1/2" and 2" Diameter in the Horizontal, Vertical, and Reverse 45° Positions.

---

17. Performance Objective

Given the proper sized pipe and the necessary oxyacetylene welding equipment, weld the pipe in horizontal, vertical, and reverse 45° positions. The weld must meet the instructor's specifications.

Criterion-Referenced Measure

Prepare and weld the pipe in the three positions to the instructor's standard.

Performance Guide

1. Select and check safety equipment.
2. Set up equipment and adjust to the desired settings.
3. Clean and bevel pipe to 30° angle.
4. Stand pipe vertically with beveled edges together.
5. Space pipe with spacer made from 1/8" welding wire.
6. Light torch and adjust to neutral flame.
7. Put one small tack between open end spacer.
8. Remove spacer and put two more small tacks equally spaced around pipe.
9. Position pipe horizontally and weld from 6 o'clock up both sides (without rotating half a turn).
10. Keep the flame pointed toward the center of the pipe.
11. The vertical fixed position is done by the backhand method. (Check textbook for torch angle and torch and torch and rod manipulation).
12. Fix the pipe at a 45° angle and weld from the bottom-up each way for the reverse 45° fixed position.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Braze Repair Castings

---

18. Performance Objective

Given a broken or cracked casting and necessary oxy-acetylene welding equipment; braze repair casting. The repaired casting will conform to its original serviceability as evidenced by an operational check. (1)

Criterion-Referenced Measure

Prepare, set up and braze broken or cracked casting to serviceable condition.

Performance Guide

1. Select safety equipment
2. Remove casting mechanically or chemically.
3. Clean casting mechanically or chemically.
4. Vee the edge as necessary.
5. Drill 1/8" hole beyond each end of crack as necessary.
6. Reinforce with studs as necessary.
7. Select rods and flux.
8. Preheat, if possible.
9. Braze and cool slowly.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Braze Ferrous and Non Ferrous Metals With Gas Equipment

---

19. Performance Objective

Given a work order, oxyacetylene equipment, tools and ferrous or non-ferrous metal project; braze project. Brazed joint must have even beads, and proper bond with smooth even puddles minus holes, craters or undercut. (1)

Criterion-Referenced Measure

Braze ferrous or non-ferrous metal joints.

Performance Guide

1. Select safety equipment.
2. Clean and prepare joints.
3. Select correct tip, filler rod and flux.
4. Turn on and adjust flame.
5. Tack parts.
6. Check Alignment.
7. Braze parts after preheating.
8. Clean and cool work piece.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Gas Weld Cast Iron

---

20. Performance Objectives

Given cast iron workpiece(s), necessary equipment, tools and materials; gas weld joint(s). Weldment must have even weld beads, penetration of parent metal, and complete fusion with smooth even beads minus holes, craters or undercut. (1)

Criterion-Referenced Measure

Gas weld cast iron joint(s).

Performance Guide

1. Select safety equipment.
2. Clean and prepare joints.
3. Select flux and filler rod.
4. Turn on and adjust for neutral flame.
5. Preheat workpiece as required.
6. Weld workpiece.
7. Clean and check weld.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Silver Braze Copper Pipe Joints

---

21. Performance Objective

Given copper pipe, gas welding equipment, and proper fitting(s); braze joint(s). Visual inspection must show the braze metal flowed and adhered making a sealed joint. (1)

Criterion-Referenced Measure

Set up, prepare copper pipe joint(s) and braze.

Performance Guide

1. Secure safety equipment.
2. Clean the joints mechanically by sanding or wire brushing.
3. Fit the joint closely and support.
4. Apply proper flux.
5. Heat to proper temperature.
6. Apply silver brazing material.
7. Cool the joint.
8. Clean the joint thoroughly.

**Duty:** OPERATING GAS WELDING EQUIPMENT

**Task:** Lead Solder Ferrous and Nonferrous Metals With Gas Equipment

---

22. Performance Objective

Given gas welding equipment, work order, lead solder, fluxes, material and tools; solder the specified joints. The joints will be smooth, continuous, and completely sealed. (1)

Criterion-Referenced Measure

Lead solder ferrous and nonferrous joints according to work order specifications.

Performance Guide

1. Select safety equipment.
2. Select correct flux for metal used.
3. Clean and flux joint.
4. Select correct welding tip size.
5. Heat metal surface and apply solder.
6. Cool and check joints for holes and capillary action.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Remove or Replace SMAW Equipment Accessories

---

23. Performance Objective

Given a SMAW machine, work order with sketch, necessary tools and accessories; remove, disassemble, inspect, reassemble and reconnect cables, ground clamp and electrode holder in accordance with and in the sequence listed in the work order. (1)

Criterion-Referenced Measure

Remove, disassemble, inspect, reassemble and reconnect cables, ground clamp and electrode holder on a SMAW unit.

Performance Guide

1. Check and make sure that electrical power is off.
2. Obtain necessary tools.
3. Remove electrode and ground cables from machine.
4. Disassemble ground clamp from cable.
5. Disassemble electrode holder from cable.
6. Inspect cables, holder and clamp.
7. Replace or repair defective parts.
8. Reassemble ground clamp to cable.
9. Reassemble electrode holder to cable.
10. Reconnect cables to machine.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Set Oven Temperature and Store ARC Electrodes

---

24. Performance Objectives

Given welding electrodes requiring oven storage; determine correct conditions and store. Oven temperature will be set as required by type and condition of electrode according to American Welding Society, Part B 4.9.2. (2)

Criterion-Referenced Measure

Store electrodes in oven and set temperature according to code specifications.

Performance Guide

1. Remove from shipping carton.
2. Place in oven.
3. Arrange and separate into different sizes and types.
4. Set oven temperature as required by type and condition of electrodes.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Shielded Metallic Arc-Weld Carbon Steel

---

25. Performance Objective

Given a SMAW machine, work order and sketch specifying carbon steel alloys, dimensions of metal, type current and electrodes; weld carbon steel alloy joints using fillet and groove welds. Visual inspection of joints will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between the weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld carbon steel alloy joints to work order specifications using the SMAW process.

Performance Guide

1. Select safety equipment.
2. Select tools and materials.
3. Set up equipment.
4. Clean and position for welding.
5. Turn on and adjust welding machine.
6. Weld joints using fillet and groove welds according to work order specifications.

NOTE: Code proficiency requires welding in the flat (F&G), horizontal (2 F&G), vertical (3 F&G) and overhead (4 F&G) positions.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Shielded Metallic Arc-Weld Heat and Corrosion Resistant (Stainless) Steels

---

26. Performance Objectives

Given a SMAW machine, work order and sketch specifying heat and corrosion resistant (stainless) steels, dimensions of metal, type current and electrodes; weld stainless steel joints using fillet and groove welds. Visual inspection of joints will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between the weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld stainless steel joints to work order specifications using the SMAW process.

Performance Guide

1. Select safety equipment.
2. Select tools and materials.
3. Set up equipment.
4. Clean and position for welding.
5. Turn on and adjust welding machine.
6. Weld joints using fillet and groove welds according to work order specifications.

NOTE: Code proficiency requires welding in the flat (F&G), horizontal (2 F&G), vertical (3 F&G) and overhead (4 F&G) positions.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Hard Surface Steel With Arc-Welding Equipment

---

27. Performance Objective

Given a steel work piece requiring build up or hard surfacing, work order, necessary equipment and materials; build-up or hard surface to the specifications included in the work order. (1)

Criterion-Referenced Measure

Build up or hard surface a piece of steel to the specifications of the work order.

Performance Guide

1. Select safety equipment.
2. Study job sheet to determine
   a. use of work piece.
   b. type of bead pattern.
   c. type of facing alloy and/or buildup materials.
3. Clean work piece.
4. Apply beads (preheat if required)
5. Finish surface to work order specifications.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Cut Carbon Steels Using Shielded Metallic Arc Cutting Process

---

28. Performance Objective

Given a work order requiring carbon steel cutting by the SMAC process, necessary tools and equipment; cut metal to ± 1/8 inch (3 mm) of work order specifications using E6010 or E6011 electrodes. (1)

Criterion-Referenced Measure

Cut carbon steel according to work order using SMAC process.

Performance Guide

1. Measure and mark metal.
2. Select safety equipment.
3. Select electrodes.
4. Set up and adjust machine.
5. Position metal.
6. Perform the cut.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Cut Cast Iron With Air Carbon Arc Process

---

29. Performance Objective

Given a work order requiring cast iron cutting and gouging by the air carbon arc process, proper tools and equipment; cut and gouge to ± 1/8 inch (3 mm) of work order specifications. (1)

Criterion-Referenced Measure

Cut and gouge cast iron according to work order using the air carbon arc cutting process.

Performance Guide

1. Select safety equipment.
2. Measure and mark metal.
3. Select carbon electrodes.
4. Set up and adjust machine and air.
5. Position metal.
6. Cut and gouge.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Cut Carbon Steels With Air Carbon Arc Process

---

30. Performance Objective

Given a work order requiring carbon steel cutting and gouging by the air carbon arc process, proper tools and equipment; cut and gouge to ± 1/8 inch (3 mm) of work order specifications. (1)

Criterion-Referenced Measure

Cut and gouge carbon steel according to work order using the air carbon arc cutting process.

Performance Guide

1. Select safety equipment.
2. Measure and mark metal.
3. Select carbon electrodes.
4. Set up and adjust machine and air.
5. Position metal.
6. Cut and gouge.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Reconstruct And Align Frames Or Related Equipment

---

31. Performance Objective

Given a work order requiring reconstruction, repair, or alignment of frame, necessary equipment and materials; align, repair or reconstruct to original dimensions and specifications. (1)

Criterion-Referenced Measure

Reconstruct and align frame or related equipment according to work order specifications.

Performance Guide

1. Select safety equipment.
2. Prepare workpieces by cutting, grinding, bending, etc. to enable finished product to conform with original contour and dimensions.
3. Align, clamp and/or tack workpieces.
4. Check alignment to meet work order specifications.
5. Weld joints adding fishplates as required for structural soundness.
6. Clean and check weld joints.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Fabricate Metal Work Stands Or Furniture

---

32. Performance Objectives

Given a work order with sketch requiring fabrication of work stands and/or furniture and necessary equipment and tools; fabricate to work order specifications. (1)

Criterion-Referenced Measure

Fabricate work stands and/or furniture to work order specifications.

Performance Guide

1. Select safety equipment.
2. Select stock per project work order.
3. Cut, bend, and grind stock per work order drawing.
4. Select correct electrode.
5. Select correct welding machine settings.
6. Align, clamp and tack workpieces.
7. Check workpieces for conformation to work order specifications.
8. Fabricate project by welding as required.
9. Check project.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Fabricate Or Construct Storage Devices

---

33. Performance Objective

Given a work order with sketch requiring fabrication of storage device, necessary equipment and tools; fabricate to work order specifications. (1)

Criterion-Referenced Measure

Fabricate storage device to work order specifications.

Performance Guide

1. Select safety equipment.
2. Select stock per project work order.
3. Cut, bend, and grind stock per work order drawing.
4. Select correct electrode.
5. Select correct welding machine settings.
6. Align, clamp and tack workpieces.
7. Check workpieces for conformation to work order specifications.
8. Fabricate project by welding as required.
9. Check project.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Prepare And Weld Pipe Joints

---

34. Performance Objectives

Given work order specifying size and type of pipe and necessary equipment, cut, set up, fit, tack and weld pipe joint to code specifications in the 2G, 5G and 6G positions. Use either American Welding Society D-10.9-69 or American Petroleum Institute, or American Society of Mechancial Engineers, Section IX, p. 4-5-2, QW-452.3. (2, 3 & 4)

Criterion-Referenced Measure

Cut, set up, fit, tack and weld pipe to specifications.

Performance Guide

1. Select safety equipment.
2. Select proper tools and equipment.
3. Check specifications for particular code.
4. Set up and regulate cutting equipment.
5. Cut pipe.
6. Bevel pipe to specifications.
7. Grind or turn in lathe as required.
8. Tack weld as per code specifications.
9. Set up and adjust arc welding equipment.
10. Select electrode of filler wire.
11. Set for purge if necessary.
12. Weld to code specifications.

NOTE: Pipe welding requires code proficiency using SMAW, GTAW and GMAW processes.

**Duty:** SHIELDED METALLIC ARC WELDING

**Task:** Shielded Metallic Arc-Weld Cast Iron

---

35. Performance Objectives

Given a section of broken cast iron, work order, and a SMAW unit; weld repair casting. The repaired casting will conform to its original configuration and strength, as evidenced by an operational check. (1)

Criterion-Referenced Measure

Arc-weld cast iron using the SMAW process.

Performance Guide

1. Select safety equipment.
2. Inspect broken casting to determine degree of bevel and prepare.
3. Inspect to determine need for machinable or non-machinable electrodes and select.
4. Align parts in original position and select the appropriate clamp(s) for welding.
5. Perform welding.
6. Grind excessive metal, if required.

**Duty:** TUNGSTEN INERT GAS WELDING (TIG)

**Task:** Disassemble and Clean GTAW (TIG) Torch Assembly

---

36. Performance Objectives

Given a complete GTAW (TIG) unit, work order with exploded view, necessary tools and accessories; remove, disassemble, reassemble and replace torch assembly in accordance with and in the sequence listed in the work order. (1)

Criterion-Referenced Measure

Remove, disassemble, reassemble and replace a GTAW (TIG) torch assembly.

Performance Guide

1. Check and make sure that electrical power, water and shielding gas are shut off.
2. Obtain necessary tools.
3. Remove torch assembly from GTAW (TIG) power source, water source and gas source.
4. Disassemble torch.
5. Inspect component parts.
6. Replace defective parts.
7. Reassemble torch assembly.
8. Connect torch assembly to power source, water source and gas source.
9. Test reassembled torch for leaks and correct operation.

**Duty:** TUNGSTEN INERT GAS WELDING (TIG)

**Task:** Weld Carbon Steels With GTAW (TIG) Equipment

---

37. Performance Objective

Given a GTAW (TIG) unit and work order specifying carbon steel alloy, dimensions of metal, type current, shielding gas, tungsten electrode and filler rod; weld carbon steel alloy joints using fillet and groove welds. Visual inspection of joints will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between the weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld carbon steel alloy joints to work order specifications using a GTAW (TIG) unit.

Performance Guide

1. Select safety equipment.
2. Set up equipment.
3. Position all cables and hoses so as not to be burned or damaged.
4. Turn on electrical equipment.
5. Turn on and check water flow, as required.
6. Turn on and adjust shielding gas.
7. Adjust current.
8. Weld joints using fillet and groove welds in all positions according to work order specifications.

**Duty:** TUNGSTEN INERT GAS WELDING (TIG)

**Task:** Weld Heat and Corrosion Resistant (Stainless) Steels With GTAW (TIG) Equipment

---

38. Performance Objective

Given a GTAW (TIG) unit and work order specifying stainless alloy steels, dimensions of metal, type current, shielding gas, tungsten electrode and filler rod; weld stainless alloy joints using fillet and groove welds. Visual inspection of joints will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between the weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld stainless steel alloy joints to work order specifications using a GTAW (TIG) unit.

Performance Guide

1. Select safety equipment.
2. Set up equipment.
3. Position all cables and hoses so as not to be burned or damaged.
4. Turn on electrical equipment.
5. Turn on and check water flow, as required.
6. Turn on and adjust shielding gas.
7. Adjust current.
8. Weld joints using fillet and groove welds in all positions according to work order specifications.

**Duty:** TUNGSTEN INERT GAS WELDING (TIG)

**Task:** Weld Chrome-Moly Steel With GTAW (TIG) Equipment

---

39. Performance Objective

Given a GTAW (TIG) unit and work order specifying chrome-moly alloy, dimensions of metal, type current, shielding gas, tungsten electrode and filler rod; weld chrome-moly alloy joints using fillet and groove welds. Visual inspection of joints will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between the weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld chrome-moly alloy joints to work order specifications using a GTAW (TIG) unit.

Performance Guide

1. Select safety equipment.
2. Set up equipment.
3. Position all cables and hoses so as not to be burned or damaged.
4. Turn on electrical equipment.
5. Turn on and check water flow, as required.
6. Turn on and adjust shielding gas.
7. Adjust current.
8. Weld joints using fillet and groove welds according to work order specifications.

**Duty:** TUNGSTEN INERT GAS WELDING (TIG)

**Task:** Fabricate Or Repair Tubing Systems

---

40. Performance Objective

Given a work order with sketch requiring fabrication or repair of tubing system, necessary equipment, tools and materials; fabricate the system to tolerances included in the work order specifications. (1)

Criterion-Referenced Measure

Fabricate or repair a tubing system as specified in work order.

Performance Guide

1. Select safety equipment.
2. Clean, grind, and bevel workpiece as required to patch material.
3. Shape patch material to conform to workpiece.
4. Perform welding operations as specified in work order.
5. Perform leakage and soundness tests.

**Duty:** TUNGSTEN INERT GAS WELDING (TIG)

**Task:** Weld Copper or Copper Alloys With GTAW (TIG) Equipment

---

41. Performance Objective

Given a GTAW (TIG) unit, work order and sketch specifying copper alloys, dimensions of metal, type current, shielding gas, tungsten electrode and filler rod; weld copper alloy joints using fillet and groove welds. Visual inspection of joints will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between the weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld copper alloy joints to work order specifications using GTAW (TIG) unit.

Performance Guide

1. Select safety equipment.
2. Set up equipment.
3. Position all cables and hoses so as not to be burned or damaged.
4. Turn on electrical equipment.
5. Turn on and check water flow, as required.
6. Turn on and adjust shielding gas.
7. Adjust current.
8. Weld joints using fillet and groove welds according to work order specifications.

**Duty:** TUNGSTEN INERT GAS WELDING (TIG)

**Task:** Weld Aluminum or Aluminum Alloys With GTAW (TIG) Equipment

---

42. Performance Objective

Given a GTAW (TIG) unit, work order and sketch specifying aluminum or aluminum alloys, dimensions of metal, type current, shielding gas, tungsten electrode and filler rod; weld aluminum joints using fillet and groove welds. Visual inspection of welds will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld aluminum joints to work order specifications using GTAW (TIG) unit.

Performance Guide

1. Select safety equipment.
2. Set up equipment.
3. Position all cables and hoses so as not to be burned or damaged.
4. Turn on electrical equipment.
5. Turn on and check water flow, as required.
6. Turn on and adjust shielding gas.
7. Adjust current.
8. Weld joints using fillet and groove welds in all positions according to work order specifications.

**Duty:** TUNGSTEN INERT GAS WELDING (TIG)

**Task:** Weld Magnesium Alloys With GTAW (TIG) Equipment

---

43. Performance Objective

Given a GTAW (TIG) unit, work order and sketch specifying magnesium alloys, dimension of metal, type current, shielding gas, tungsten electrode and filler rod; weld magnesium alloy joints using fillet and groove welds. Visual inspection of joints will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between the weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld magnesium alloy joints to work order specifications using the GTAW (TIG) unit.

Performance Guide

1. Select safety equipment.
2. Set up equipment.
3. Position all cables and hoses so as not to be burned or damaged.
4. Turn on electrical equipment.
5. Turn on and check water flow, as required.
6. Turn on and adjust shielding gas.
7. Adjust current.
8. Weld joints using fillet and groove welds according to work order specifications.

**Duty:** METAL INERT GAS WELDING (MIG)

**Task:** Disassemble and Clean a GMAW (MIG) Torch Assembly

---

44 Performance Objective

Given a complete GMAW (MIG) unit, work order with exploded view, necessary tools and accessories; remove, disassemble, reassemble and replace torch assembly in accordance with and in the sequence listed in the work order. (1)

Criterion-Referenced Measure

Remove, disassemble, reassemble and replace a GMAW (MIG) torch assembly.

Performance Guide

1. Check and make sure that electrical power, water and shielding gas are shut off.
2. Obtain necessary safety equipment.
3. Obtain necessary tools.
4. Remove filler wire from GMAW (MIG) torch and cable assembly.
5. Remove torch and cable assembly from GMAW (MIG) power source, wire feeder, water source and gas source.
6. Dissassemble GMAW (MIG) torch.
7. Clean and inspect component parts.
8. Replace defective parts.
9. Reassemble GMAW (MIG) torch assembly less contact tip and nozzle.
10. Connect gun and cable assembly to power source, wire feed, water source and gas source.
11. Feed wire through torch and cable assembly and install contact tip and nozzle.
12. Test reassembled torch for leaks and correct operation.

**Duty:** METAL INERT GAS WELDING (MIG)

**Task:** Weld Carbon Steels With GMAW (MIG) Equipment

---

45. Performance Objective

Given a GMAW (MIG) unit, work order and sketch specifying dimensions, type of current, type of gas, filler wire and joint design; weld carbon steel joints using fillet and groove welds in all positions. Visual inspection of joints will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between the weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld carbon steel to work order specifications using a GMAW (MIG) unit.

Performance Guide

1. Select safety equipment.
2. Set up the equipment.
3. Position all cables and hoses so as not to be burned or damaged.
4. Turn on electrical equipment.
5. Turn on and check water flow as required.
6. Turn on and adjust the shielding gas.
7. Adjust wire feed, voltage, amperage and stick out.
8. Weld joints using fillet and groove welds in all positions according to work order specifications.

**Duty:** METAL INERT GAS WELDING (MIG)

**Task:** Weld Stainless Steel Alloys With GMAW (MIG) Equipment

---

46. Performance Objective

Given a GMAW (MIG) unit, work order and sketch specifying dimensions, type of current, type of gas, filler wire and joint design; weld stainless steel alloy joints using fillet and groove welds in all positions. Visual inspection of joints will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between the weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld stainless steel alloy joints to work order specifications using (GMAW) MIG unit.

Performance Guide

1. Select safety equipment.
2. Set up the equipment.
3. Position all cables and hoses so as not to be burned or damaged.
4. Turn on electrical equipment.
5. Turn on and check water flow, as required.
6. Turn on and adjust the shielding gas.
7. Adjust wire feed, voltage, amperage and stickout.
8. Weld joints using fillet and groove welds in all positions according to work order specifications.

**Duty:** METAL INERT GAS WELDING (MIG)

**Task:** Weld Aluminum or Aluminum Alloys With GMAW (MIG) Equipment

---

47. Performance Objective

Given a GMAW (MIG) unit, work order and sketch specifying dimensions, type of current, type of gas, filler wire and joint design; weld aluminum joints using fillet and groove welds in all positions. Visual inspection of welds will show:

a. smooth and continuous welds.
b. complete penetration.
c. fusion between weld bead and base metal.
d. no cracks, undercutting or overlap. (1)

Criterion-Referenced Measure

Weld aluminum to work order specifications using a GMAW (MIG) unit.

Performance Guide

1. Select safety equipment.
2. Set up the equipment.
3. Position all cables and hoses so as not to be burned or damaged.
4. Turn on electrical equipment.
5. Turn on and check water flow as required.
6. Turn on and adjust the shielding gas.
7. Adjust wire feed, voltage, amperage and stickout.
8. Weld joints using fillet and groove welds in all positions according to work order specifications.

# APPENDIX A

# EQUIPMENT AND TOOLS

EQUIPMENT AND TOOLS BY PERCENTAGE AND NUMBER OF MEMBERS USING

| EQUIPMENT NUMBER | EQUIPMENT DESCRIPTION | PERCENTAGE OF MEMBERS USING | NUMBER OF MEMBERS USING |
|---|---|---|---|
| 1 | Anvil | 62 | 81 |
| 2 | Apron Welding | 48 | 63 |
| 3 | Angle Dividers | 52 | 68 |
| 4 | Air Compressor | 77 | 100 |
| 5 | Band Saw Blade Welder | 48 | 62 |
| 6 | Box and Pan Break | 28 | 36 |
| 7 | Brush,Bench | 69 | 90 |
| 8 | Brush,Wire | 95 | 123 |
| 9 | Chisel,Cold | 90 | 117 |
| 10 | Chisel, Impact | 45 | 59 |
| 11 | Clamp, Vice Grips | 92 | 120 |
| 12 | Clamp Bar, Quick Acting | 52 | 67 |
| 13 | Clamps, C Type | 92 | 119 |
| 14 | Clamp, Quick Release Chain | 28 | 37 |
| 15 | Crayons, Soapstone | 94 | 122 |
| 16 | Crayons, Heat | 42 | 54 |
| 17 | Cutter,Bolt | 52 | 67 |
| 18 | Cutter,Pipe | 66 | 86 |
| 19 | Cutting Machine, Straight Line Flame | 45 | 59 |
| 20 | D C Power Source Motor, Driven Gasoline | 57 | 74 |
| 21 | Drill, Electric 1/4 Inch | 78 | 101 |
| 22 | Drill, Electric 3/8 Inch | 79 | 103 |
| 23 | Drill, Electric 1/2 Inch | 82 | 107 |
| 24 | Drill, Twist, Letter Set | 52 | 68 |
| 25 | Drill, Twist, Number Set | 58 | 76 |
| 26 | Drill Stand, Fractional | 47 | 61 |
| 27 | Drill, Twist Straight Shank, Fractional Set | 52 | 68 |
| 28 | Drill Press | 78 | 102 |
| 29 | Dresser, Abrasive Wheel | 75 | 97 |
| 30 | Die Tapping | 68 | 88 |
| 31 | Die Letter Set | 47 | 61 |
| 32 | Die Number Set | 51 | 66 |
| 33 | Extractor Screw Set | 45 | 59 |
| 34 | Files, Flat Bastard Double Cut | 87 | 113 |
| 35 | Files, Mill Smooth | 75 | 97 |
| 36 | Files, Mill | 71 | 92 |
| 37 | Files, Round Bastard | 83 | 108 |
| 38 | Files, Round Second-Cut | 58 | 75 |
| 39 | Files, Three-Square Second-Cut | 59 | 77 |
| 40 | File Card and Brush | 48 | 62 |
| 41 | Gauge, Fillet | 43 | 56 |
| 42 | Gloves, Asbestos Pair | 45 | 58 |
| 43 | Gloves, Leather Pair | 92 | 119 |
| 44 | Gloves, Thick Rubber Pair | 15 | 20 |
| 45 | Goggle, Brazing | 91 | 118 |
| 46 | Grinder Belt | 38 | 50 |

EQUIPMENT AND TOOLS BY PERCENTAGE AND NUMBER OF MEMBERS USING

| EQUIPMENT NUMBER | EQUIPMENT DESCRIPTION | PERCENTAGE OF MEMBERS USING | NUMBER OF MEMBERS USING |
|---|---|---|---|
| 47 | Grinder Pedestal | 73 | 95 |
| 48 | Grinder, Portable | 84 | 109 |
| 49 | Grinder, Surface | 42 | 54 |
| 50 | Guided Bend Tester | 20 | 26 |
| 51 | Hammer, Ball Peen | 92 | 119 |
| 52 | Hammer, Sledge | 81 | 105 |
| 53 | Hammer, Chipping | 92 | 119 |
| 54 | Hammer, Soft Face | 59 | 77 |
| 55 | Hardness Tester | 10 | 13 |
| 56 | Helmet, Grind Face Shield | 85 | 111 |
| 57 | Helmet, Welding Arc Head Type | 95 | 123 |
| 58 | Heat Treating Oven | 15 | 20 |
| 59 | Hydraulic Jack | 81 | 105 |
| 60 | Hydraulic Pipe Binder | 18 | 23 |
| 61 | Iron Working Machine | 39 | 51 |
| 62 | Mallet, Rawhide | 34 | 45 |
| 63 | Mallet, Rubber | 47 | 61 |
| 64 | Metal Identification Kits | 12 | 16 |
| 65 | Metallographic Polisher | 2 | 3 |
| 66 | Nipper, End Cutting | 39 | 51 |
| 67 | Parallels, Adjustable | 17 | 22 |
| 68 | Pencil, Air Grinders | 44 | 57 |
| 69 | Pipe Bevelling Machine | 20 | 26 |
| 70 | Pliers, Combination | 82 | 106 |
| 71 | Pliers, Diagonal Cutting | 68 | 88 |
| 72 | Pliers, Needle Nose | 73 | 95 |
| 73 | Pliers, Straight Nose | 67 | 87 |
| 74 | Pliers, Vice-Grip Wrench | 88 | 114 |
| 75 | Power Roll | 25 | 33 |
| 76 | Power Shear | 33 | 43 |
| 77 | Punch Center | 75 | 98 |
| 78 | Punch Drive | 44 | 57 |
| 79 | Quenching Tank | 38 | 49 |
| 80 | Reamer Pipe | 42 | 54 |
| 81 | Rule, Circumference 36 inch | 35 | 46 |
| 82 | Rule, Flexible Steele Tape 10 ft-12 ft | 90 | 117 |
| 83 | Rule, Hook | 29 | 38 |
| 84 | Rule, Short Set | 25 | 33 |
| 85 | Rule, Steel 6 Inch | 57 | 74 |
| 86 | Rule, Steel 12 Inch | 56 | 73 |
| 87 | Rule, Steel 24 Inch | 41 | 53 |
| 88 | Saw, Hack Hand | 91 | 118 |
| 89 | Saw, Hack Power | 55 | 72 |
| 90 | Saw, Band Power | 65 | 84 |
| 91 | Shear, Alligator Jaw | 22 | 29 |

EQUIPMENT AND TOOLS BY PERCENTAGE AND NUMBER OF MEMBERS USING

| EQUIPMENT NUMBER | EQUIPMENT DESCRIPTION | PERCENTAGE OF MEMBERS USING | NUMBER OF MEMBERS USING |
|---|---|---|---|
| 92 | Shear, Nibbler Portable | 25 | 33 |
| 93 | Shear, Slitting | 12 | 15 |
| 94 | Shear, Squaring Foot | 12 | 16 |
| 95 | Screwdrivers, Phillips | 82 | 107 |
| 96 | Screwdrivers, Standard Bit | 88 | 114 |
| 97 | Sparklighters | 88 | 114 |
| 98 | Slip Roll Former | 11 | 14 |
| 99 | Square, Combination | 88 | 115 |
| 100 | Square, Framing | 84 | 109 |
| 101 | Tensile Testing Machine | 9 | 12 |
| 102 | Tongs, Blacksmith Curved Lip | 25 | 33 |
| 103 | Tongs, Pick-up | 35 | 46 |
| 104 | Truck Welding Cylinder | 53 | 69 |
| 105 | V Block and Clamps Set | 38 | 49 |
| 106 | Vise, Angle Drill | 34 | 44 |
| 107 | Vise, Bench Drill | 52 | 68 |
| 108 | Vise Pin Set | 18 | 23 |
| 109 | Vise Pipe | 52 | 67 |
| 110 | Welder, Arc A C | 88 | 115 |
| 111 | Welder, Flux-Cored | 35 | 46 |
| 112 | Welder, MIG | 53 | 69 |
| 113 | Welder, Spot | 22 | 29 |
| 114 | Welder, Submerged ARC | 11 | 14 |
| 115 | Welder, TIG | 70 | 91 |
| 116 | Welder, Oxy-Acetylene | 85 | 111 |
| 117 | Welder, MAPP Gas | 11 | 14 |
| 118 | Wrench, Impact | 52 | 67 |
| 119 | Wrench, Adjustable End | 88 | 115 |
| 120 | Wrench, Allen Key Hex Set | 88 | 114 |
| 121 | Wrench Box Set | 78 | 101 |
| 122 | Wrench, Open End Set | 82 | 107 |
| 123 | Wrench, Pipe | 77 | 100 |
| 124 | Wrench, Socket 3/8 inch drive set | 75 | 98 |
| 125 | Wrench, Socket 1/2 inch drive set | 75 | 98 |
| 126 | Wrench, Gas Torch | 73 | 95 |

TOTAL RESPONDENTS - 130

# APPENDIX B

# SOURCE OF STANDARDS

## SOURCE OF STANDARDS

1. Florida Writing Team
2. American Welding Society
3. American Society of Mechanical Engineers
4. American Petroleum Institute
5. Modern Welding - Welding Principles and Practice - Raymond Sacks - Charles A. Bennett & Co. Inc., Peoria, Ill.
6. American Technical Society, - Chicago, Ill.
7. Welding Curriculum Guide - 1972-73, Fairfield County Vocational Center, Fairfield, S. C.

# APPENDIX C

# STATE OF THE ART

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## COMBINATION WELDER

Welds metal parts together, according to layouts, blueprints, or work orders, using both gas welding or brazing and any combination of arc welding processes (shielded metallic arc, TIG, MIG). Performs related tasks, such as cutting (flame, arc or manual), grinding and metal identification. May position and clamp components of fabricated metal products preparatory to welding. Performs layout, fitting, aligning and tack welding of metal projects preparatory to finish welding by self or others.

## SUMMARY OF THE STATE-OF-THE-ART SURVEY

The initial search of the literature for the state-of-the-art in welding included a computer survey through the FERIC (Florida Educational Resources Information Center) and a manual search of the AIM (Abstracts of Instructional Materials) and ARM (Abstracts of Research Materials) compilations. From these reviews certain pertinent materials and projects were identified and letters of inquiry forwarded to the specific publishers and agencies to attain copies of these materials. Inquiries were directed to the Departments of Education of Alabama, Oregon, and Texas; Texas A&M University, Ohio State University, University of Connecticut and the University of Michigan; military training centers; and certain leading industries in the welding area.

A review of the obtained materials disclosed:

1. The main body of curriculum materials are process oriented and did not contribute significantly to identifying tasks for this skill.

2. The military training documents provided the best guides for developing task statements.

3. The state boards of education as well as state and industrial research and training guides provided some sources of standards and task lists.

A list of the state-of-the-art literature may be obtained by writing:

The Florida Department of Education
Division of Vocational Education
Tallahassee, Florida 32304

and requesting: State-of-the-Art-Combination Welding.

The outlook for employment among welders in Florida follows fairly well the national outlook as seen by the U. S. Department of Labor Bulletin 8175, Occupational Outlook Handbook, 1976-77.

"Job opportunities for welders should be very good in the years ahead. Employment in this field with many jobs is expected to increase faster than the average for all occupations through the mid 1980's as a result of the generally favorable long-run outlook for metal working industries and the greater use of welding."

The Florida Department of Commerce estimates the 1976 employment of welders and flame cutters to be 13,710 and projects this to rise to 15,830 by the year 1980.

The greatest concentrations of Florida welding opportunities occurs in Planning District 10 (*Broward, Dade, Martin, Monroe, Palm Beach and St. Lucie Counties*) with a projected 1980 employment of 4,290 and annual increase of 200 positions; Planning District 8 (*Hillsborough, Manatee, Pasco, Pinellas and Sarasota Counties*) with a projected 1980 employment of 3,686 and annual increase of 170 positions; and Planning District 6 (*Brevard, Indian River, Lake, Orange, Osceola, Seminole and Volusia Counties*) with a projected 1980 employment of 1,920 and annual increase of 100 positions.[1]

Additionally there is a large number of positions available to welders (especially those located in the western panhandle) in the ship yards of Mobile and the near Mississippi coast.

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[1]Florida Department of Commerce, Florida Employment Directions, Industries and Occupations, 1970-1980.